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Season 1926

Jan. 3 10 17 24 30 | Feb. 7 14 21 28 | March. 7 14 21 28 | April. 4 11 18 25 | May. 2 9 16 23 30 | June. 6 13 20 27 | July. 4 11 18 25 | Aug. 1 8 15 22 29 | Sept. 5 12 19 26 | Oct. 3 10 17 24 31 | Nov. 7 14 21 28 | Dec. 5 12 19 26

Soil Moisture.

Soil Moisture.

20%

15%

10%

Average daily Wind

Wind

100m

50m

0m

Crop

400 lbs

300

200

100

0

A... Top pruned.
B... Unpruned.
C... Total crop.

Crop

Vapour Pressure

Temperature 100°F

Rainfall

10"

8"

6"

4"

2"

0"

90°

80°

70°

60°

50°

40°

Maximum Temperature

Minimum Temperature

Rainfall

0·90 ins

0·80

0·70

0·60

0·50

0·40

Vapour Pressure

Observations made at Tocklai Experimental Station

METEOROLOGICAL OBSERVATIONS IN ASSAM 1926.

By

C. R. Harler and C. J. Harrison.

In describing below the general weather conditions in Assam during 1926 it is realised that the degree of correlation between the weather and its effect on the tea bush is, so far, a very small one. Eventually, as the number of observations increases, the degree of correlation which can be followed will no doubt be much greater, but at present there is little more than the actual yield to consider in relation with the weather. Yield alone is most confusing, for it is the final result of a great number of factors. Yield can only be understood when growth is understood.

In addition to the weather, the method of cultivation and plant treatment has an influence on the crop, which varies with the weather. When it is considered that the incidence of pests and blights is also influenced by the weather, the difficulties of the problem of crop correlation with meteorological observations, in the light of our meagre knowledge, will be understood.

The 1926 Season in Assam.—The first rain at Tocklai fell on January 9th after a drought lasting 61 days.

In March, growing conditions were excellent and the bushes started to flush early. In April however only 2.1 inches of rain was registered, the lowest on record. The May rainfall was about average, but most of it fell in the first fortnight so that during the latter half of the month rainfall was short.

During the first half of June rain was again short and this, combined with the high temperatures and fierce sun, was followed by a severe attack of rim blight. From the table given below it will be seen that growing conditions were much less favourable than during the corresponding period in 1925.

The Period 14th May to 14th June.

	1925.	1926.
Temperature Maximum	86·0°F	90·9°F
Rainfall	13·31 ins.	6·85 ins.
Degree of wetness	10·7	3·4
Sunshine	4·7 hrs.	6·1 hrs.
Wind	57 miles/day	42 miles/day
Humidity	82	76
Soil Moisture	17·5%	16·4%

The second flush materialised in June, but the bushes afterwards failed to give much leaf till the blight went. The weather in July, August and September was ideal and crops were big during those months.

The first half of October was blazing hot and humid, and everything pointed to a good back-end. From the middle of the month, however, temperature fell off sharply and humidity decreased, with the result that November was normal and December poor.

The following table shows the rapid change to cold weather conditions after the middle of October.

Week ending.	Temperature.		Average Relative Humidity.	Total Rainfall.	Total Sunshine.
	Max.	Min.			
30th September ...	90·0°F	73·3°F	93	2·34 ins.	42 hrs.
7th October ...	90·6°F	73·6°F	90	1·85 ins.	35 hrs.
14th October ...	85·3°F	69·6°F	89	1·37 ins.	38 hrs.
21st October ...	86·3°F	70·2°F	88	0·52 ins.	38 hrs.
28th October ...	82·3°F	65·7°F	91	0·71 ins.	30 hrs.
4th November ...	82·0°F	61·5°F	95	nil.	44 hrs.
11th November ...	81·0°F	57·2°F	97	nil.	51 hrs.

The rise in relative humidity at 8 A.M., after the middle of October, indicates the commencement of morning fogs and mists.

The end of the season is governed largely by the temperatures, which are in turn controlled by the movement of the monsoon. The table below shows the average maximum and

minimum temperatures from September to the end of the year for past eight seasons.

Table showing maximum and minimum temperatures at Tocklai.

Season.	September.		October.		November.		December.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	°F	°F	°F	°F	°F	°F	°F	°F
1919	85	75	83	72	78	64	73	54
1920	89	76	85	70	81	59	75	52
1921	88	75	82	71	80	60	72	53
1922	89	76	85	68	80	59	73	50
1923	87	76	84	69	80	60	74	50
1924	88	75	87	73	77	62	73	54
1925	87	72	83	66	79	53	73	43
1926	89	72	86	69	79	55	74	49
Average	88	75	84	70	79	59	73	51

November 1926, it will be observed, is the second coldest on record, nearly approaching last year, when the season's close was very early.

Below is a table showing the rainfall at Tocklai during 1926 together with the average for the past nine years.

Table showing rainfall at Tocklai.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Total.
Average 9 years	0·95	1·35	3·59	7·89	9·66	12·43	17·04	13·04	10·11	4·47	0·92	0·37	81·79
1926	0·81	0·73	6·72	2·10	8·56	9·73	19·13	14·35	6·72	5·54	0·92	0·37	74·67

As the number of years during which our observations have been taken increases, the average becomes of more value, and any departure from such average gains in significance. It is interesting to note that the average rainfall at Jorhat, two miles from Tocklai, taken over a period of 50 years is 81.89 and the monthly average closely agrees with that at Tocklai.

Air Movement.

The total air movement is measured daily at Tocklai. At present only two and a half years' records are available and they are quot-

ed below in full. The figures denote average miles of wind per day.

Table showing wind at Tocklai.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1924 ...	...	...	...	...	...	40	40	37	31	27	24	13
1925 ...	42	37	55	74	30	44	46	45	46	26	16	16
1926 ...	22	43	55	74	55	47	48	40	30	21	20	18

The increase in wind up to April is marked in both years, as is also the decline as the monsoon weakens. Although in 1925 there were windy days, *e.g.*, January 14th, 404 miles, April 28th, 490 miles, no such windy days were registered in 1926, although 135 miles were registered once in April.

The violent wind storms expected early in the year, which usually do serious damage, have been absent for the past three years.

Sunshine.

The table shows the average monthly sunshine in hours, recorded for the past nine years at Tocklai, together with the values for 1926.

Table showing sunshine at Tocklai.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average (9 years)	5·3	5·7	5·7	4·9	4·7	4·2	4·0	4·4	3·9	5·8	5·6	5·2
1926 ...	5·4	5·5	5·2	5·9	5·5	4 4	3·6	4·8	4·1	5·1	6·8	5·9

It is well known that in the entire absence of light plants become yellow, owing to loss of green colouring matter, or chlorophyll. It is this chlorophyll which, in some way not yet understood, brings about the building up of complete plant constituents and tissue under the influence of light. This process is known as photosynthesis. Sunlight is composed of seven

visible light rays—*viz.*, red, orange, yellow, green, blue, indigo and violet known collectively as the "visible spectrum." There are in addition the invisible "infra-red," or heat rays, and the "ultra violet" rays, also invisible, which affect the photographic plate.

Plant growth is stimulated by heat up to about 90° F but much above this temperature, definite harm results. Although the sun temperature during the rains is generally above 130°F, the temperature of leaf itself is much lower, owing to the cooling effect of transpiration of moisture from the leaf cells. However, at times it is obvious from the sun scorching and yellowing that takes place during very dry hot spells, that the temperature of the leaf is too high for normal growth.

During the rains, though the sun temperature is at its maximum, there are less actual hours of sunshine per day, and the air and soil are more humid than during the cold weather. This explains why the foliage of the bush remains green during the rains, but yellows as the cold weather approaches.

Our sunshine recorder does not measure the intensity of the sun, but only the number of hours of bright sunshine. A measure of the intensity of sunshine is obtained by use of the Solar radiation thermometer, described in a previous number of the Journal.

It is the power of these heat rays mainly which the Solar radiation thermometer records. During the cold weather the angle of the sun in the sky is lower than in the rains for a corresponding period of the day. This means that the rays are more concentrated during the rainy season than in the cold weather and, in the former case, are more powerful. The table below shows the effect of the angle of the sun on the solar radiation, or intensity of heat rays.

Average Monthly Solar Radiation.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Solar radiation in °F	105	108	121	125	133	136	137	133	135	130	121	114

The values agree fairly well with those of 1925, except that in the latter year the temperatures at the end of the season were lower. Thus October 1925 showed a value of 123° F, November 116° F, and December 105° F.

This value must be taken in connection with the hours of sunshine, for if the sun appears for a short period the same maximum solar radiation may be registered as when it shines for a whole day. Thus on two consecutive days in July the solar radiation was 139°F and 138° F. On the first day the sun shone for 6½ hours and on the second day for 12 minutes.

Regarding light intensity, it has been observed that light favours the formation of small leaves, whilst low light intensity favours the formation of large leaves. The most favourable intensity, however, varies with time of exposure. These observations fit in with our experience in tea, where heavy shade "draws up" the bush and makes coarse leaf.

Again, in connection with light intensity, it has been noticed that light-leaved bushes are in more need of shade than dark-leaved bushes.

The study of sunshine is also important from the point of view of blight attack. It has been noticed that a dull, humid spell makes for the spread of Brown and Grey blights. In this connection the sunshine records at Sylee, in the Dooars, and at Toklai for the past two years are of interest.

The first table shows the hours of sunshine per mensem at Sylee.

Hours of sunshine at Sylee.

	April.	May.	June.	July.	Aug.	Sept.
1925	118	101	124	94	96	86
1926	180	147	91	68	127	170

Hours of sunshine at Tocklai.

	April.	May.	June.	July.	Aug.	Sept.
1925	105	102	156	158	135	117
1926	177	170	131	112	149	124

A sunny season, especially a sunny spring, in the Dooars is associated with light mosquito attack. No sunshine records other than those quoted above are available for the Dooars, but it seems probable that what is regarded as a sunny season in the Dooars may show a record of hours of sunshine no greater than is the general average in Assam. In Sylhet where, from experience only, it is assumed that the hours of sunshine exceed those in Assam, a sunny start means a severe drought usually, and a serious weakening of the bushes.

If, as often happens, May and June are fairly dry, the effect of excessive sunshine will be considerable, since the sun's power is greater during June than at any time of the year, the sun reaching its maximum altitude on the 21st of June.

Soil Temperatures.

In the plains of North-East India the soil temperatures, even at a depth of three feet, never fall below 60° F and remain over 75° F during the plucking season. During the rains the surface temperature is above that at about three feet depth, and the close of the plucking season is marked by a drop in the surface temperature below that at three feet, this state of affairs persisting throughout the cold weather until the rains and the plucking season commence again.

Below are given the average monthly soil temperatures for the past four years, taken at depths of one foot and three feet, at 8 A.M. and 3 P.M.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 A.M.												
1 ft.	63·22	65·82	70·65	74·22	80·06	84·96	86·62	86·50	85·08	81·98	73·20	55·48
3 ft.	67·20	68·29	71·60	76·19	79·37	84·41	86·06	86·15	85·60	82·12	76·80	70·52
3 P.M.												
1 ft.	65·61	68·16	73·51	78·51	82·08	87·51	88·20	88·81	86·19	83·05	75·07	60·33
3 ft.	67·40	68·07	71·88	76·26	79·50	84·43	86·10	86·99	85·57	82·91	76·92	71·01

It will be seen from the above table that from about the end of April to the middle of August the soil temperature at 8 A.M. is constant to a depth of three feet but by the afternoon the surface of the soil has warmed up. At the end of

January and November the soil temperature was constant to three feet depth during the afternoon, but during the morning the surface was cooler than the underlying layer.

Soil Moisture.

The question of the amount of water in a soil is of primary importance in agriculture, since plant growth is directly dependent on water, not only as a medium for the transport of plant food, but as a means of bringing the various cell and tissue-building materials into close juxtaposition so that synthesis may take place. There is however an optimum moisture content, which, if exceeded, results in harm to the bush. With too much water in the soil, nitrogen-fixing, and nitrifying bacteria, which require air, are unable to work, and their place is taken by harmful bacteria which do not require air, and undo the work of the bacteria which assist plant growth.

The only source of soil water in practically every tea area is rainfall which is unevenly distributed throughout the year. During the rains, there are nearly always long spells when there is a surfeit of rain, and undrained land becomes waterlogged. During the cold weather, there are periods of drought when the soil dries out unless measures such as mulching and shading are taken to prevent or minimise such drying.

The optimum water content of the Tocklai soil is about 17 or 18 per cent. During the cold weather 1925-1926, with a sixty days' drought from the middle of November to the middle of January, the soil moisture fell as low as 8.5 per cent. and remained at about 10 per cent. until the beginning of March. The highest percentage moisture recorded last year was 21 per cent., while from the beginning of May to the end of November, the soil moisture remained close to the optimum.

Soil Moisture at Tocklai.

	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1926	11%	10%	16%	14%	17%	17 %	19%	19%	18%	17·7%	15%	13·7%
1927	15%	15%										

It will be seen that the cold weather of 1926-27 has witnessed a very different state of affairs from the preceding cold weather. At no time has there been any drying out of the soil, which is in excellent condition, and, unless a very prolonged drought occurs before the rains come, the 1927 season should prove an ideal one from a point of view of the health of the tea bush.

Relative Humidity.

During January the relative humidity was 90-100 per cent. for about 12 hours during each day. From 7-30 P.M., the humidity drops gradually to 60 per cent. or 55 per cent. at 4 P.M., after which it again rises to nearly 100 per cent. at 7-30 P.M. At mid-day the humidity varies considerably—on wet cloudy days remaining at 85 or 90 per cent., and on dry days dropping to 70-75 per cent.

During February the humidity at night is still 100 per cent. but the drop during the day is greater, and the humidity at 4 P.M. is as low as 40-50 per cent.

In March and April, with its cool rainy spells and occasional spells of hot dry weather, the humidity varies considerably from day to day. During dry spells the daily drop in humidity is as much as 60 per cent. while on wet days the drop may be only 35 or 40 per cent.

By the middle of April the humidity seldom drops below 60 per cent. and, by the time the monsoon arrives, in June the humidity remains generally between 100 per cent. and 70 per cent.

The beginning of October is marked by a drop in night and day humidity, the former to a maximum of 90 per cent. or 95 per cent. and the latter back to 60 per cent.

During November, the night air is saturated, causing fogs, this state of affairs persisting usually throughout the cold weather.

ANALYSIS OF PHOSPHATIC MANURES.

By

H. R. Cooper and P. B. Sen Gupta.

In connection with the trials of phosphatic manures reported in the last number of this Journal a number of analyses were performed.

This was done with the primary object of defining the material which was tried. Very different mineral phosphates may be exported, for example, from Belgium or Algeria; basic slags, superphosphates, and bone dusts differ in quality; while mineral phosphates, treated or untreated, which are sold under particular trade names, convey by their names no idea of their nature.

As a secondary object it was desired to discover whether there was a correlation between any of the figures obtained by analysis, and the efficiency of the manure as determined by an actual field test.

Field tests require a long time to carry out; entail relatively high expenditure and use of labour; and the results obtained are subject to a fairly high degree of error, and apply strictly only to the particular soil on which the trial was made.

If it could be shown that analytical figures obtained in the laboratory were related to figures from field trials, it would be possible to reduce greatly the number of field trials required.

The addition of a phosphatic manure produces changes in the soil in two main directions.

First. The amount of phosphoric acid available to plants growing in the soil is increased.

Second. The acidity of the soil may be changed significantly.

Leguminous plants are benefited greatly on our acid soils, both by addition of available phosphoric acid and by decrease in the acidity of the soil. The presence of large quantities of iron-oxide and alumina in the manure added might possibly prove harmful, since, if sufficiently soluble, they might combine with phosphoric acid to form very insoluble compounds.

The determinations shown in Table I therefore, were made.

Table I.

	Per cent.						
	Total phosphoric acid.	Phosphoric acid soluble in 2% citric acid.	Oxides of iron & alumina.	Total lime.	Lime as carbonate.	Acidity reducing power equivalent to lime.	Total nitrogen.
	1	2	3	4	5	6	7
Basic slag	17·86	14·80	24·8	44·74	1·8	37·7	trace
Superphosphate	20·85	water soluble	...	...	nil	—10·5	trace
Bone dust	21·19	13·20	...	25·88	nil	12·1	3·25
Algerian phosphate	26·54	9·57	10·6	38·42	6·6	29·29	0·46
Belgian phosphate	21·94	2·04	10·0	42·84	17·4	35·78	trace
Plutophos	35·47	6·51	4·0	46·54	2·2	25·26	trace
Radiophos	23·47	0·89	28·4	29·18	nil	5·26	trace
Singhbhum phosphate	35·21	2·36	15·4	45·30	nil	15·23	trace
Indophos	26·03	1·78	10·4	37·30	nil	15·12	trace

The figure in the sixth column was determined by treating a weighed quantity of the material with decinormal hydrochloric acid, and bringing just to boiling. The amount of hydrochloric acid neutralised was then determined by titration with caustic soda. Superphosphate, of course, has no power of neutralising acid, but, on the contrary, is acid itself, and this particular sample is sufficiently acid to neutralise 10½ per cent. of its own weight of lime. Its "acidity reducing power" is therefore entered as a negative quantity.

Comparison of these figures is best made by calculating from the above figures the quantities per acre actually added to the soil, and comparing these with the relative efficiencies of the manures as determined by field trial.

Table II

	Relative efficiency in field trial.	lbs. applied per acre.			
		Total Phosphoric acid.	Phosphoric acid soluble in 2% citric acid.	Acidity reducing power equiv. to lbs. lime.	Nitrogen.
Basic slag ...	100	80	64·5 ...	169	nil
Superphosphate ...	87	80	(water soluble)	nil, on contrary neutralises 40 lbs. lime.	nil
Bone dust ...	82	80	49 8	46	12·1
Algerian phosphate ...	85	80	28·8	88	1·4
Belgian phosphate ...	60	80	7·4	131	nil
Plutophos	32	80	14·6	57	nil
Radiophos ...	13	80	3·1	18	nil
Singhbhum phosphate	5	80	5·4	34	nil
Indophos	9	80	5·5	47	nil

When comparing different basic slags it has been found that the percentage of phosphoric acid soluble in 2 per cent. citric acid does give a fair idea of the probable efficiency of the slag in the field. It will be seen from the above figures that there is only a very rough correspondence between citric-acid-soluble phosphoric acid, and relative efficiency in the field of other phosphates.

The field results from bone dust and basic slag agree very fairly with the citric soluble phosphate found. The small quantity of nitrogen supplied by the bone dust does not appear to have increased the efficiency of the manure greatly. The Algerian phosphate, however, giving only 45 per cent. as much citric soluble phosphoric acid as basic slag, showed 85 per cent. as high efficiency in the field as did basic slag. The nitrogen present in the Algerian phosphate was due to accidental admixture of 1.8 per cent. nitrate of potash. It is very improbable that this small admixture can have increased very greatly the manurial value of the Algerian phosphate. A fresh sample of the Algerian phosphate, uncontaminated by nitrate of potash, gave the same percentage of available phosphoric acid as the contaminated sample. However, the admixture makes the field result from Algerian phosphate open to doubt.

The low percentage of citric-acid-soluble phosphoric acid in Belgian phosphate is very striking for a manure of such high efficiency in the field. Plutophos provides double as much phosphoric acid soluble in citric acid as does Belgian phosphate, but shows only half the efficiency in the field. The efficiency of the Belgian phosphate is no doubt greatly increased by its relatively high acidity reducing power, since reduction of the acidity of the acid soil on which the trials were made has a great good effect on the growth of the leguminous plant used, *mati kalai* (Phaeseolus spp.) Radiophos, Indophos, and the Singhbhum phosphate, all of which have a practically negligible efficiency in the field, show both very low citric soluble phosphoric acid, and very low acidity reducing power. These two tests together, therefore, may be of some value in enabling us to pick out, by laboratory tests alone, mineral phosphates which are likely to have no value on our acid soils, for the purpose of growing a green crop; but on the whole it can be said that only field trial can give reliable measurements of efficiency.

Superphoshate, which has no acidity reducing power as measured by the method used, might be expected to be un-

suitable for use with leguminous crops in acid soils. The field trial, however, shows it possesses a fairly high efficiency in increasing growth of *mati kalai* on an acid soil.

Although superphosphate has no power of reducing the acidity of a simple strong acid, it actually reduces the acidity of the complex mixture of substances in the soil. This is explained through its power of combining with and rendering insoluble the more soluble of the complex aluminium compounds which are responsible for the mineral acidity of North-East India tea soils.

Superphosphate of course reduces acidity much less than basic slag, and it is for this reason only that it proves less efficient than basic slag on acid soils.

Previous trials have shown that when used with lime it is exactly as efficient as basic slag.

In addition to chemical properties, fineness of division is always a big factor in determining the availability in the soil of an insoluble phosphate. In all the above materials grinding had been so fine that the use of sieves fails to show up the number of extremely fine particles present. Hall's method, which is used to separate soils into particles between certain limits of size, was therefore adopted for the separation of different sized particles of these manures. Particles of the size of "clay" and "fine silt" were estimated together. Distilled water was used for the flotation instead of dilute ammonia.

Per cent.	Moisture.	Particles of diameter in millimetres.			
		1 to ·2 "Course sand."	·2 to ·04 "Fine sand."	·04 to ·01 "Silt."	Below ·01 "Fine silt and Clay."
Basic slag	1·28	24·8	52·1	10 5	9·6
Bone dust	10·86	58·2	19·6	2·9	4·5
Algerian phosphate ...	7·56	6·9	54·3	24·1	3·0
Belgian phosphate ...	0·74	nil	98·3	0·5	0·4
Plutophos	1·16	31·7	45·8	8·3	13·0
Radiophos	2·94	29·1	45 8	11·0	10·4
Indophos	0·46	3·50	67·6	13·5	14·7
Singhbhum phosphate ...	0·36	nil	55·3	23·0	20·6

The whole of each sample passed a one millimetre sieve. The " coarse sand " is the amount which fails to pass a sieve of about 100 meshes to the inch. The other fractions were determined by flotation.

Algerian phosphate and bone dust contained a little water soluble matter.

The Belgian phosphate is remarkably even in the size of its particles, practically all falling within the range of fine sand. This makes it extremely easy to handle, since it " runs " very freely. It contains practically no very fine particles, but judging from its efficiency in the field, particles of fine-sand size appear to be sufficiently small. The Singhbhum phosphate is beautifully finely ground, it feels between the fingers almost as an impalpable powder. Indophos also is very finely ground. Very fine grinding is, obviously, not enough to render such insoluble materials efficient as quick-acting manures.

ANALYSES OF SOILS AND MANURES.

Since the abolition of the analytical branch in 1914, the whole time of the staff of the Chemical Branch is occupied in research, and analyses of soils or manures for the benefit of individual gardens cannot be undertaken by this Department. Arrangements have been made that such analyses will be made by Calcutta analysts, strictly according to methods laid down by the Chief Scientific Officer.

Before being placed on the Indian Tea Association list, all analysts have been interviewed, and their laboratories inspected by the Chief Scientific Officer.

Each analyst, also, analyses a check sample of soil, sent annually from Tocklai, and reports results to the Chief Scientific Officer. These results are compared with previously ascertrained correct results, and any disagreement is reported to the analyst concerned, who is asked to check his method.

These precautions ensure that results obtained by analysts on the Indian Tea Association list may be relied upon. The following analysts are now on the Indian Tea Association list and will carry out full analyses of soils for a fee of Rs. 56 per sample.

1. Messrs. Bird & Co.,
   Research Department,
   Chartered Bank Buildings, Calcutta.
2. Messrs. R. V. Briggs & Co.,
   8/B, Lall Bazar Street,
   Calcutta.
3. Messrs. J. & R. Hutchison,
   1 and 2, Hare Street,
   Calcutta.
4. Messrs. Smith Stanistreet & Co., Ltd.,
   18, Convent Road, Entally,
   Calcutta.
5. Messrs. D. Waldie & Co.,
   1, British Indian Street,
   Calcutta.

The analyses, when obtained, should be sent to the Chief Scientific Officer, who will report upon the quality of a manure, or on the probable agricultural value of a soil, and suggest correct manurial and other treatment for it.

Samples of soils or manures should not be sent to Tocklai unless asked for for purposes of research.

Method of taking Soil Samples.

Soils in North-East India vary greatly from place to place and a single piece of earth cut from one place, can only by accident truly represent the section from which it was taken. Manures also are not always evenly applied, and such a single piece of earth may include, for example, a lump of lime, or of animal meal, so that the analysis might give a very wrong idea of the real average soil.

The bulk sample sent for analysis should always be a mixture of a number of small samples taken in different places.

The following procedure is recommended :—

Select a patch of soil of about 20 yards square, which appears fairly to represent the section to be sampled, in colour and texture, and in size and health of tea bushes..

Within this area samples should be taken from at least ten different points.

Generally a sample of surface soil only, to 9 inches depth, is required. This is most easily taken with an ordinary carpenter's auger (2 inches diameter).

This should be screwed in to 9 inches depth, withdrawn by a straight pull, and the adhering soil rubbed off into a box.

For full analysis about 2 lbs. soil are required.

A 2-inch auger takes about 1½ ozs. of soil, so that about twenty such borings will be necessary..

Sometimes surface soil and subsoil may be markedly different. A layer of clay may overlie sand or *vice-versâ;* clay or sand may overlie peat or *vice-versâ.* In that case a sample of the subsoil should also be taken, and described, for example, thus :—

SAMPLE NO 1.—Section No. 8, Top 9 inches.
SAMPLE NO. 2.—Section 8, Subsoil 12 inches to 21 inches.

The earth auger may also be used to take subsoil samples. When the top nine inches has been removed in taking the sample of surface soil, the auger should be screwed in to 12 inches (or other depth at which different soil occurs), withdrawn and adhering soil thrown away. The auger is then screwed in to a further nine inches, pulled out, and adhering soil collected.

If the soil is loose and dry, it will not adhere to the auger. Samples should, for this reason, be taken when the soil is moist, or compacted sufficiently to adhere to the auger.

When a sample is taken it should always be marked with the number or name of the section from which it comes. We have on our files many analyses marked only with a letter or a number, and these are now useless to the garden concerned because no one knows where they came from.

INFORMATION WHICH SHOULD ACCOMPANY A SOIL ANALYSES.

The reason for sending the analyses should be given. It saves unnecessary writing if it is stated whether the land is virgin jungle proposed for new planting, tea in fair condition for which a maintenance programme of manuring is required, or poor tea thought to require particularly good treatment. Poor tea may be growing on good soil, or good tea on a poor soil, if well treated. The constitution of the soil is only one of the factors which affect growth.

The following information therefore should be given :—

1. Age of tea.
2. Jat of tea.

3. Distance apart of planting.
4. Notes on drainage and lie of land.
5. Pruning for last five years.
6. Manuring for last five years.
7. Yield for last five years.
8. Pests and blights recognised to be present, if any; and treatment given, if any.
9. Whether tea is shaded, and if so, kind of tree used and distances apart.
10. Condition of roots, and nature of root growth. An average plant should be taken up and described, or better still, the whole plant sent in to Tocklai.
11. Colour of soil.

If a rotation of manuring is required to be suggested the following information should also be given :—

(1) Total area to be manured.
(2) Number of acres which can be given cattle manure at ten tons per acre, or top-dressing.
(3) Number of acres which can be given quick growing green crops (*e.g.*, cowpeas, dhaincha, sunn hemp).
(4) Number of acres which can be given semi-permanent green crops, *e.g.*, Boga medeloa, Arhar.
(5) Price at which oilcake is obtainable, locally.
(6) Amount per acre proposed to be expended annually in manuring.

AN OUTBREAK OF BLISTER BLIGHT IN THE SURMA VALLEY.

By

A. C. Tunstall.

In the cold weather of 1926-27 specimens of Blister blight, *Exobasidium vexans*, Massee, were received for the first time from the Surma Valley. This disease had been reported from this valley a number of times but subsequent investigation showed that in each case the reports were incorrect. Mr. Gupta, Manager of Sabazpore Tea Estate, forwarded some specimens of the disease early in December. He reported that the disease appeared on a few bushes in two widely separated areas on his garden during the first week in December. As the fungus takes about ten days from the date of infection to produce fruits it is probable that the spores were introduced about the middle of November. Outbreaks of the disease were reported from many gardens in North-West Cachar, where it apparently arrived about the same time. Specimens were next received from the Hailakandy District and it was later discovered in the Longai and Chargola Districts of Sylhet and the Happy Valley District of Cachar. It would appear, therefore, that the disease is distributed all over the North of the Surma Valley.

The writer visited many of the gardens concerned and endeavoured to trace the origin of the outbreak.

Seed.

Attention was given to the possibility of the disease arriving from other infected areas in consignments of seed. In none of the cases investigated, however, had any seed been imported from infected areas for over a year previous to the appearance of the disease. The distribution of the disease on the individual gardens also did not favour the suggestion that the spores were introduced with seed.

Climatic Conditions.

A comparison of the climatic conditions with those of previous years showed no striking differences. It did not appear probable, therefore, that the disease had been present for some time and had only attacked the tea, because of exceptional climatic conditions favouring the fungus. It would appear that the spores of the fungus were not present in previous years and that, somehow or other, they have been introduced recently. A study of the situation of the gardens attacked shows that, while the gardens in North-West Cachar, on the slopes of the Khasia and Jaintia hills, appeared to be attacked indiscriminately, those gardens, situated in the valleys further South, were not so attacked. Only those on the Western side of each valley were involved. The gardens to the East of the valleys were and still remain uninfected. Unfortunately, comparatively few records are kept of the direction of the wind in these districts but the Meteorological Department of the Government of India kindly supplied some data. From this data, it would appear that at the time of the year the disease appeared, the wind to the North of Shillong was from the North-East. Further South, it veered round and at Silchar, was East to North-East. In North Cachar, it was North to North-East. If the spores of the fungus were borne by this wind, it is possible to explain the appearance of the disease on the gardens to the West of the valleys concerned, as these gardens would be exposed to the Easterly and North-Easterly winds while, those situated to the East would be to some extent protected. The gardens concerned are so widely separated and in some cases so well isolated that it is difficult to account for the distribution of the spores of the fungus except by the wind. If, however, the spores came on the wind, whence did they come and why did they not come before? These questions can only be settled by a careful investigation of the jungle in the hills to the North of the Surma Valley. It is well known that another species of *Camellia, Camellia drupifera,* is present in that district and that this species is attacked by a species of *Exobasidium,* but this

fungus differs from that which attacks tea. The species of *Exobasidium,* now attacking the tea in the Surma Valley, is identical with that which is found on tea in other districts. It is, however, possible that the tea species is capable of attacking *Camellia drupifera* or some other plant present in the jungle concerned. The spores may have been carried by the wind to the Khassia, Jaintia and North Cachar hills and infected wild plants in those hills. These in turn may have acted as the centres of infection whence the present outbreak originated. It is of course possible that the spores were carried all the way from the areas previously known to be infected but this is unlikely, as, if it were possible, it is difficult to account for the fact that the disease has not been found in the Surma Valley before.

If the disease has been distributed from recently infected areas to the windward of the Surma Valley, it is probable that the disease will appear again next cold weather, whenever the wind lies in the right direction. It is, therefore, important to ascertain if possible the centres of infection and to study the possibilities of removing them. For this purpose a special tour has been arranged.

In the meantime every effort should be made to eradicate the disease wherever it is found in the Surma Valley. Whether the disease will come again on the wind next cold weather remains to be seen but whether it does or not, the eradication of the fungus actually present in the Surma Valley, should be vigorously attempted. It is unlikely that the disease will do very serious damage in the Surma Valley, on account of the temperatures in the rains being normally too high to enable the fungus to thrive. It should, however, be pointed out that the requirements of fungi sometimes change and the fungi may become adapted to changed conditions. This is readily conceivable when the enormous numbers of their spores and their rapid growth are considered. It is therefore, important to prevent the disease becoming permanently established on the tea in the Surma Valley.

The following suggestions will help the Surma Valley planters to deal with the disease.

Blister blight is caused by a fungus called *Exobasidium vexans,* Massee. This fungus only attacks the young succulent growth. It enters the leaf or green stem at the tiny openings through which the plant transpires. About 10-11 days after infection visible signs of the disease appear and "blisters" are full grown, in from 11—18 days from the time of infection. The blight at first appears as round, translucent pale yellow, sometimes pink, spots on the leaf. As the disease progresses these spots enlarge into white or pinkish, convex warts, mostly on the under-surface of the leaf. The opposite surface is pale green, yellow or pink, with concave depression. At a later stage these convex warts shrink and darken into deep brown, almost black spots, which dry up, sometimes crack and fall out, leaving round holes in the leaf.

Where the blight is observed on one or two bushes only, the safest treatment is to pluck off all succulent leaf from the bushes concerned. This leaf should not be carried about in baskets, etc., as by so doing the spores are further distributed by air currents. If the leaves cannot be conveniently burned or buried on the spot they should be placed in the nearest drains. As the spores die very quickly after the diseased material is plucked the danger of infection from such material does not last long.

Unfortunately, the disease is distributed very readily by the wind and frequently a considerable area becomes infected before attention is drawn to it.

On account of its preference for succulent growth, cut back tea is specially liable to infection and when the attack is severe, the green shoots may die right back to old wood. The removal of all succulent growth would do as much harm to such bushes as the blight, so it is necessary to apply other remedies. The best is to spray the bushes concerned thoroughly with Lime-sulphur solution. As the disease may be growing within the tissues for 10 or 11 days and the spray fluid would have

no influence on it until it is exposed (*e.g.*, in the "blister" stage) it is necessary to spray more than once. I suggest weekly applications to such infected areas until there be no more signs of the disease.

Where the disease is present on considerable areas of unpruned tea, the areas concerned should be skiffed or better still light pruned and all succulent wood removed. The prunings should be burned but on no account should they be carried through uninfected areas. The whole of the infected area should then be thoroughly sprayed with Lime-sulphur solution. If all succulent growth is removed, it will not be necessary to spray again, as no leaf likely to contain the fungus will be present.

On some gardens the disease has already become general and stray blisters may be found on all sections. In these cases it is impossible to eradicate the fungus at once. I recommend the following procedure :—

1. It is very probable that the hot dry winds usually prevalent in the Surma Valley during the early part of the season will kill off most of the disease, especially on exposed areas. In damp shady places, however, the fungus may continue to thrive throughout the year. Such places should be searched at intervals and wherever the disease is found, succulent leaf should be removed and the bushes thoroughly sprayed immediately after.

2. Spray all cut back areas or other tea, likely to suffer severely from loss of succulent growth, immediately the disease appears on such areas.

3. Skiff, or better still, light prune all unpruned areas found to be infected. If it is essential to leave certain areas unpruned those areas must be thoroughly sprayed after plucking all succulent growth.

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